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PLANT COMMUNITY PREFERENCES OF SOME MYXOMYCETE SPECIES IN GOMOLSHA FORESTS (UKRAINE)

Abstract
Plant community preferences of 22 species of Myxomycetes were investigated in seven plant communities of the Gomolsha Forests National Nature Park (Kharkov region, Ukraine). The data obtained indicate that despite the lack of correlation to a type of plant community, Myxomycetes species are united in the groups with the certain system of community preferences. The belonging of a myxomycete to a preference group is not the same as its association with a certain plant community. It indicates a certain niche, occupied by a species in different plant communities (i.e. dominant, subdominant, outsider). A similar preference pattern is demonstrated by species developing on different substrata or belonging to distant taxonomic groups.
KEY WORDS: Forest-Steppe, Ukraine, phytosociology of Myxomycetes.

Introduction

The ecology of Myxomycetes is a relatively new field of knowledge. Studies on the plant community preferences of these organisms began only at the end of 1970's [2]. The major approaches to investigate vegetation factors on a myxomycete biota are: (1) comparison of different regions and climatic zones with the attempt to reveal biogeographical regularities [14], and (2) comparison of different plant communities within the limits of one territory. The latter approach is of our interest here.

Studies on the myxomycete species composition in different plant communities were conducted in many regions of the world. At the temperate zone, several comparative investigations were done in forests of *Acer*, *Castanea*, *Celtis*, *Juniperus*, *Fagus*, *Picea*, *Pinus*, *Populus*, *Quercus*, *Tamarix*, *Taxodium*, and *Tsuga* [6, 13, 17]. These studies concluded that different plant communities supported different myxomycete associations. Differences were noticeable in the species richness and diversity, ratio of leading orders, and distribution on the plant substrata. Therefore the type of plant community probably affected the biota of Myxomycetes.

On the other hand, it is well known that many myxomycete species are not connected with a specific type of plant community, but could be found in many types of vegetation [12]. Seemingly, the influence of vegetation was indirect, or somehow subject to other factors.

One can assume that the type of a substratum is much more important for Myxomycetes, than the type of plant community. Myxomycete species are seemingly limited to the type of substratum (bark, wood, litter, moss), and to certain substrate forming plants [7]. Similar regularities were also found for the level of superspecific taxa [5]. It was shown, that such properties of substrata as pH, microrelief and hygroscopicity, seriously influence the structure of myxomycete biota [15, 18]. As a rule, substrate specialization is much more pronounced than the other ones [17]. It's reasonable to assume, that Myxomycetes do not 'ask' what forest to prefer, oak or pine, but what wood (or bark) to prefer, deciduous or coniferous.

However, we can't ignore that some other features of vegetation play a role in forming the Myxomycetes biota. Plant communities can differ from each other by density of an undergrowth and epiphytic cover, by speed of wood decomposition, by temperature mode, humidity, and etc.

It was shown, that many of the abovementioned factors are important for Myxomycetes, and sometimes influence the specific structure of myxomycete associations no less than a substratum. Many species are adapted to certain humidity conditions and are considered as xero-, meso-, or hygrophytes [17]. Superspecies taxa also possess similar regularities: Trichiales and Physarales

were shown to be relatively hygrophylic, Stemonitales and Liceales being xerophylic [16]. In plant communities which have similar substrate-forming plants, but different microclimate (i.e. “moist” or “dry” oak forest), the species composition of Myxomycetes is not similar [10].

Epiphytic cover also influences the myxomycete biota. When epiphyte density increases, the number of Myxomycetes usually decreases [16]. Some species of Myxomycetes prefer to develop on mosses, while lichens are hardly ever occupied by Myxomycetes [7].

Thus, specialization of Myxomycetes to the type of vegetation probably is not reduced to their substrate specialization. The choice of the plant community for myxomycete means a choice of several significant parameters, where substratum is the most important, but not the only one.

Nevertheless, it is unclear what role the plant community plays in defining the biota of Myxomycetes. Is it possible to speak about the plant community specialization of these organisms? Or we can talk only about the specialization to substratum and microclimatic factors? How could we combine the multifactorial individuality of plant communities with the fact, that Myxomycetes do not show a strict specialization to a vegetation type? The present study was undertaken to make a contribution toward resolving this question.

Material and methods

The material used in the present study consists of about 1000 specimens of Myxomycetes collected in the Gomolsha Forests National nature park (East forest-steppe of the Ukraine) during the period 2000-2004. All specimens are deposited in the Scientific Herbarium of the V.N. Karasin National University of Kharkov (CWU-myc).

Seven forest plant communities were involved in the analysis, including oak forest (*Quercus robur* L.), maple-lime-oak forest (*Acer platanoides* L., *Tilia cordata* L. and *Q. robur*), white poplar forest (*Populus alba* L.), pine forest (*Pinus sylvestris* L.), oak-pine forest (*Q. robur* and *P. sylvestris*), aspen forest (*Populus tremula* L.), and birch forest (*Betula pendula* Roth). In these communities, data on the occurrence of 22 Myxomycetes species were analyzed (see Table 1).

For comparison of the data from different plant communities, relative occurrence of species was calculated, as the number of specimens in each plant community relative to total number of specimens, found in that plant community. Relative occurrence defines the degree of species domination in a community. I.e. if the species show high relative occurrence, close to the possible maximum for some community, it can be interpreted as dominant. If the species demonstrate a medium relative occurrence, it can be interpreted as subdominant, and if low – as the outsider of occurrence.

The scale of wood decomposition [1] was used to compare the substrata, occupied by the species. The nomenclature of Myxomycetes is given according to C. Lado [8, 9]. Correlation analysis was carried out according to standard procedures [4]. Calculations were made with the help of computer programs Statistica 6.0 and MS Excel under Widows XP.

Results and discussion

The relative occurrences of each species in each plant community (tab. 1) were plotted, showing the patterns of species distribution in different communities (fig. 1). The similarity of some results is evident (for example, *Arcyria affinis* and *Trichia varia*, *A. cinerea* and *A. obvelata*. This evidence was affirmed with the help of Pearson’s correlation coefficient. The calculations have shown, that the significant correlations are observed between visually similar patterns (tab. 2).

The analysis of correlations between species has shown an unusual result. The species, which spectra significantly correlate, appear to form distinct groups (fig. 2). The majority of such group members are connected with each other and form an entire network. At the same time, there is no statistically significant similarity between individual members of different groups. This result allows the conclusion that, from the point of plant community preferences, myxomycete species form distinct groups, which are detached from each other.

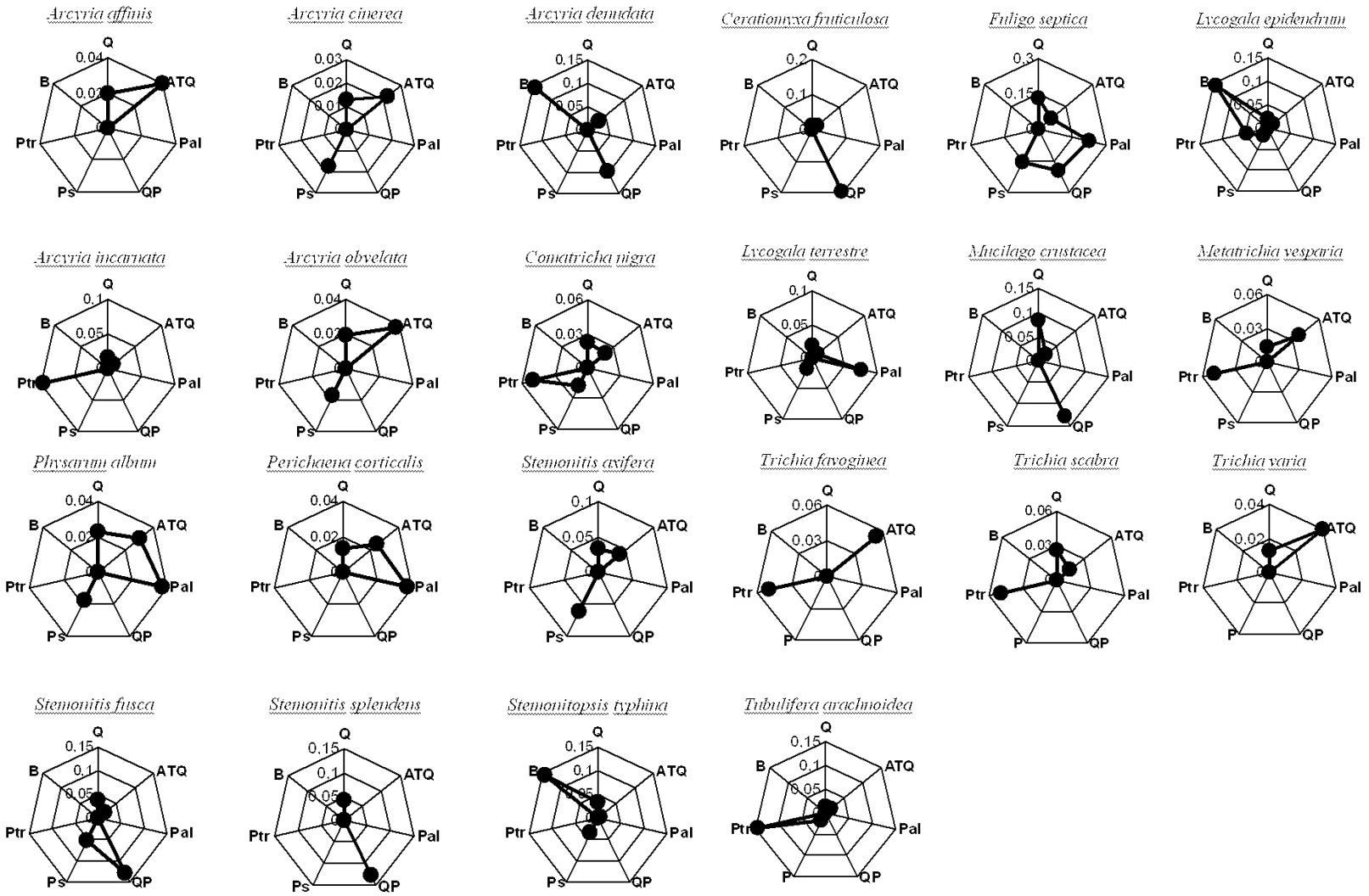

Fig. 1. Patterns of plant community preferences of 22 species of Myxomycetes.
Scales show the relative occurrence of a particular species in the various communities. For abbreviations and basic calculations, see Tab.1.

Tab. 1. Occurrence of 22 species of Myxomycetes in plant communities of Gomolsha Forests.
I – absolute occurrence (number of specimens), II – relative occurrence. **ATQ** – community of *Acer platanoides*, *Tilia cordata* and *Quercus robur*, **Q** – community of *Q. robur*, **Pal** – community of *Populus alba*, **B** – community of *Betula pendula*, **Ptr** – community of *Populus tremula*, **QP** – community of *Q. robur* and *Pinus sylvestris*, **Ps** – community of *P. sylvestris*.
Underlined letterers are used for abbreviated ('acronymic') names of species in further tables and figures.

Plant communities / Myxomycete species	ATQ		Q		Pal		B		Ptr		QP		Ps	
	I	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**
Arcyria affinis Rostaf.	16	0.040	6	0.020	0	0	0	0	0	0	0	0	0	0
A. cinerea (Bull.) Pers.	9	0.022	4	0.013	0	0	0	0	0	0	0	0	2	0.018
A. denudata (L.) Wettst.	12	0.030		0	0	0	2	0.143	0	0	3	0.097	0	0
A. incarnata (Pers. ex J.F. Gmel.) Pers.	4	0.010	5	0.016	0	0	0	0	4	0.098	0	0	0	0
A. obvelata (Oeder) Onsberg	15	0.037	6	0.020	0	0	0	0	0	0	0	0	2	0.018
Ceratiomyxa fruticulosa (O.F.Müll.) T.Macbr.	7	0.017	4	0.013	0	0	0	0	0	0	6	0.194	0	0
Comatricha nigra (Pers. ex J.F. Gmel.) J. Schröt.	8	0.020	7	0.023	0	0	0	0	2	0.049	0	0	2	0.018
Fuligo septica (L.) F.H. Wigg.	30	0.075	40	0.130	12	0.222	0	0	0	0	6	0.194	18	0.158
Lycogala epidendrum (L.) Fr.	6	0.015	6	0.020	0	0	2	0.143	2	0.049	0	0	2	0.018
L. terrestre Fr.	4	0.010	6	0.020	4	0.074	0	0	0	0	0	0	2	0.018
Metatrichia vesparia (Batsch) Nann.-Bremek.	8	0.020	26	0.085	0	0	0	0	0	0	4	0.129	0	0
Mucilago crustacea F.H. Wigg.	15	0.037	4	0.013	0	0	0	0	2	0.049	0	0	0	0
Perichaena corticalis (Batsch) Rostaf.	12	0.030	7	0.023	2	0.037	0	0	0	0	0	0	2	0.018
Physarum album (Bull.) Chevall.	10	0.025	4	0.013	2	0.037	0	0	0	0	0	0	0	0
Stemonitis fusca Roth	16	0.040	10	0.033	0	0	0	0	0	0	0	0	7	0.061
S. splendens Rostaf.	8	0.020	12	0.039	0	0	0	0	0	0	4	0.129	6	0.053
S. axifera (Bull.) T. Macbr.	0	0	13	0.042	0	0	0	0	0	0	4	0.129	0	0
Stemonitopsis typhina (F.H. Wigg.) Nann.-Bremek.	2	0.005	10	0.033	0	0	2	0.143	0	0	0	0	4	0.035
Trichia favoginea (Batsch) Pers.	6	0.015	4	0.013	0	0	0	0	6	0.146	0	0	2	0.018
T. scabra Rostaf.	6	0.052	8	0	0	0	0	0	2	0.049	0	0	0	0
T. varia (Pers. ex J.F. Gmel.) Pers.	16	0.015	4	0.026	0	0	0	0	0	0.049	0	0	0	0
Tubulifera arachnoidea Jacq.	16	0.040	4	0.013	0	0	0	0	0	0	0	0	0	0
TOTAL	**401**		**307**		**54**		**14**		**41**		**31**		**114**	

It is interesting to note that among 22 analyzed species only two (9.1 %) have no correlations with any found group (*Arcyria denudata* and *Fuligo septica*). We cannot assume, do these species have the unique system of preferences, or they belong to preference groups, other members of which were omitted in the analysis. Generally, five groups of plant community preferences were revealed. The number of species in these groups varies from two up to six (see fig. 2). The fact that groups differ from each other by the number of species possibly indicates the distinctions between communities in ecological capacity. The analysis of group structure allows characterization of the general system of plant community preferences, which is typical for each group. Group 1 (*Lycogala epidendrum* and *Stemonitopsis typhina*) is characterized by high relative occurrence in birch forest (here and further see fig.1). Group 2 (*Lycogala terrestre*, *Perichaena corticalis*, *Physarum album*) dominates in white poplar forest, and is quite usual (subdominant) in maple-lime-oak forests (except for *L. terrestre*). Group 3 (*Ceratiomyxa fruticulosa*, *Mucilago crustacea*, *Stemonitis fusca*, *S. splendens*) prevails in oak-pine and oak forests. Group 4 (*Arcyria affinis*, *A. cinerea*, *A. obvelata*, *Stemonitis axifera*, *Trichia varia*) dominates in maple-lime-oak and pine forests. Group 5 (*Arcyria incarnata*, *Comatricha nigra*, *Metatrichia vesparia*, *Trichia favoginea*, *T. scabra*, *Tubulifera arachnoidea*) unites species prevailing in maple-lime-oak and aspen forests. Finally, among those species which are not included in any group, *Fuligo septica* dominates in pine, oak-pine and white poplar forests and *Arcyria denudata* in birch and oak-pine forest.

Thus, in Gomolsha Forests Myxomycetes show the following preferences:

1. Birch forest (group 1)
2. Oak, pine and white poplar forests (group 2)
3. Oak and oak-pine forests (group 3)
4. Maple-lime-oak and pine forests (group 4)
5. Oak, maple-lime-oak and aspen forests (group 5)
6. Oak-pine, pine and white poplar forests (*Fuligo septica*)
7. Birch and oak-pine forests (*Arcyria denudata*)

It's worthy to note that the structure of preferences does not simply show that the considered groups unite the species, preferring to develop in one or several certain plant communities. The placement of a species within a group means that the species is dominant in one community and can concurrently being subdominant in second and outsider in third. For example, *Arcyria affinis* and *Trichia varia* (members of group 4) tend to be dominant in maple-lime-oak forests, and subdominant in oak forests; *Stemonitis fusca* and *S. splendens* (members of group 3) are dominant in oak-pine forests and outsiders in oak forest. Therefore, if a species occurs in several types of plant communities, this does not mean that it is indifferent to this factor. In each community, the species consistently occupy a certain place, quite different from its place in a community of another type.

The obvious preference phenomena are found in the "birch forest" and "birch and oak-pine forest" groups, containing boreal geoelement, which is not typical for the forest-steppe. The group "oak and oak-pine forest" is formed by prevalence of *Quercus robur*. The group "oak, maple-lime-oak and aspen forest" is probably united by similar structure of grass and bush vegetation. Such interpretations can be also offered for other preference groups, but all of them will have a hypothetical character. However, the possible number of groups, formed from seven units equals 127 (this number was calculated as a sum of combinations from n elements by m: $C_n^m = \frac{n!}{m!(n-m)!}$, where n = 7, m = 1...7). Thus, five established groups of preference make up only 3.9% of that potentially possible number. This fact itself shows the high specificity and regular nature of found preferences.

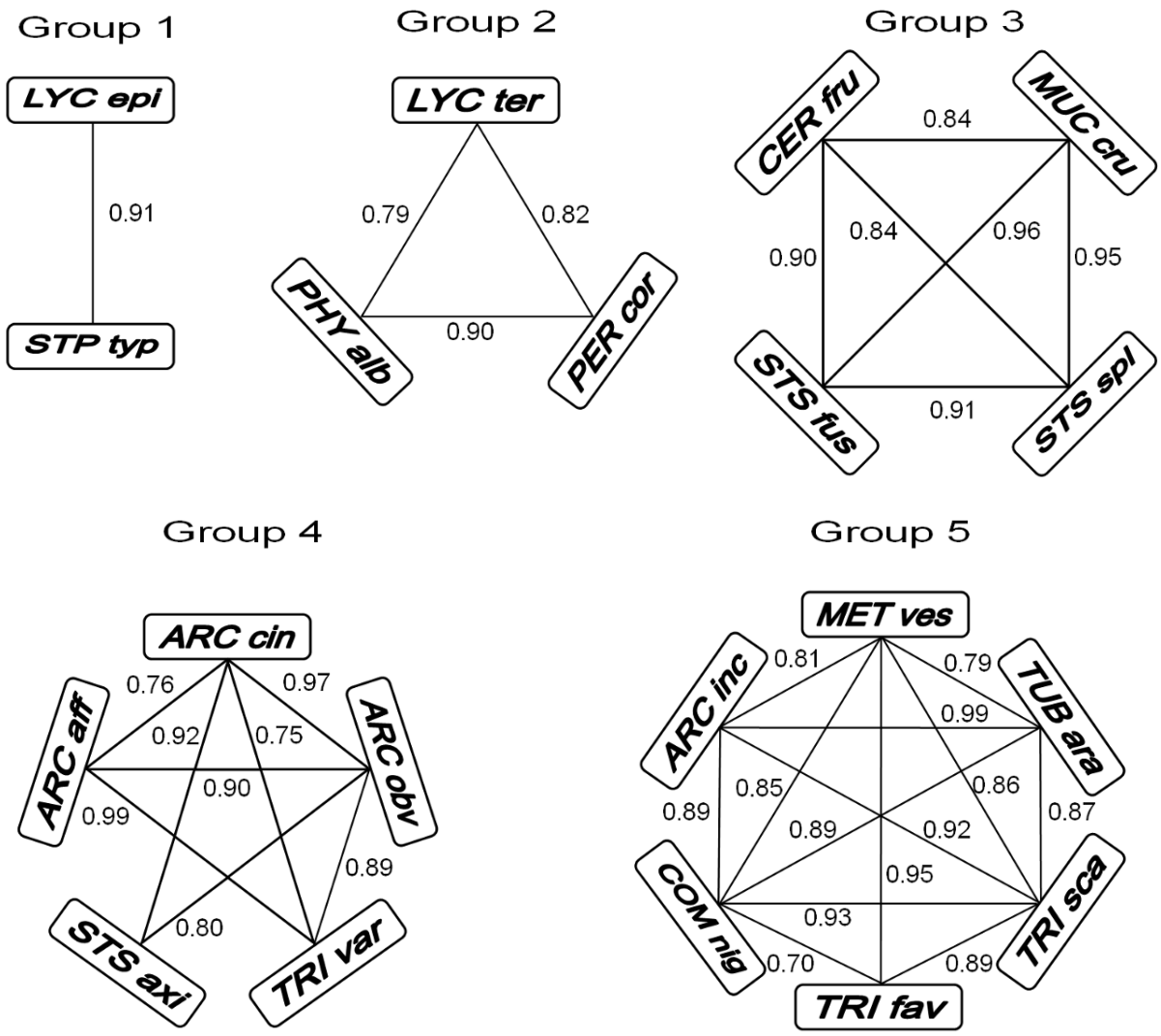

Fig. 2. Species composition and interspecific correlations in community preference groups of Myxomycetes.

Numbers indicate Pearson's correlation coefficients (only significant values; see tab.2). For species acronyms see Tab.1

Tab. 2. Pearson's correlation between relative occurrences of Myxomycetes species.
Marked correlations are significant ($p<0.05$). For species acronyms see Tab.1.

	ARC AFF	ARC CIN	ARC DEN	ARC INC	ARC OBV	COM NIG	CER FRU	FUL SEP	LYC EPI	LYC TER	MUC CRU	MET VES	PHY ALB	PER COR	STS AXI	STS FUS	STS SPL	STP TYP	TUB ARA	TRI FAV	TRI SCA	TRI VAR
ARC AFF	1.00	**0.76**	-0.20	-0.10	**0.90**	0.19	-0.14	-0.13	-0.23	-0.10	0.10	0.47	0.50	0.43	0.46	-0.11	-0.14	-0.20	-0.16	0.53	0.19	**0.99**
ARC CIN	**0.76**	1.00	-0.40	-0.24	**0.97**	0.22	-0.27	0.05	-0.32	-0.08	-0.07	0.21	0.51	0.18	**0.92**	0.02	-0.26	-0.16	-0.20	0.28	0.00	**0.75**
ARC DEN	-0.20	-0.40	1.00	-0.36	-0.34	-0.58	0.43	-0.29	0.65	-0.47	0.22	-0.38	-0.60	-0.41	-0.45	0.23	0.35	0.68	-0.38	-0.27	-0.46	-0.16
ARC INC	-0.10	-0.24	-0.36	1.00	-0.20	**0.89**	-0.23	-0.57	0.08	-0.30	-0.23	**0.81**	-0.37	-0.27	-0.26	-0.34	-0.22	-0.29	**0.99**	0.66	**0.92**	-0.10
ARC OBV	**0.90**	**0.97**	-0.34	-0.20	1.00	0.22	-0.23	-0.02	-0.30	-0.10	-0.02	0.33	0.53	0.29	**0.80**	-0.03	-0.23	-0.19	-0.20	0.41	0.07	**0.89**
COM NIG	0.19	0.22	-0.58	**0.89**	0.22	1.00	-0.37	-0.51	-0.07	-0.33	-0.23	**0.85**	-0.15	-0.23	0.20	-0.31	-0.33	-0.34	**0.89**	**0.70**	**0.93**	0.17
CER FRU	-0.14	-0.27	0.43	-0.23	-0.23	-0.37	1.00	0.41	-0.34	-0.30	**0.84**	-0.27	-0.39	-0.28	-0.29	**0.90**	**0.96**	-0.29	-0.25	-0.22	-0.28	-0.13
FUL SEP	-0.13	0.05	-0.29	-0.57	-0.02	-0.51	0.41	1.00	**-0.77**	0.64	0.41	-0.59	0.51	0.43	0.15	0.52	0.44	-0.50	-0.56	-0.56	-0.54	-0.15
LYC EPI	-0.23	-0.32	0.65	0.08	-0.30	-0.07	-0.34	**-0.77**	1.00	-0.42	-0.39	-0.04	-0.54	-0.44	-0.31	-0.45	-0.35	**0.91**	0.08	-0.05	0.00	-0.22
LYC TER	-0.10	-0.08	-0.47	-0.30	-0.10	-0.33	-0.30	0.64	-0.42	1.00	-0.26	-0.33	**0.79**	**0.82**	-0.05	-0.31	-0.28	-0.30	-0.31	-0.31	-0.30	-0.11
MUC CRU	0.10	-0.07	0.22	-0.23	-0.02	-0.23	**0.84**	0.41	-0.39	-0.26	1.00	-0.23	-0.22	-0.19	-0.11	**0.84**	**0.95**	-0.27	-0.30	-0.30	-0.08	0.03
MET VES	0.47	0.21	-0.38	**0.81**	0.33	**0.85**	-0.27	-0.59	-0.04	-0.33	-0.23	1.00	-0.05	0.02	0.01	-0.37	-0.31	-0.38	**0.79**	**0.95**	**0.86**	0.49
PHY ALB	0.50	0.51	-0.60	-0.37	0.53	-0.15	-0.39	0.51	-0.54	**0.79**	-0.22	-0.05	1.00	**0.90**	0.41	-0.29	-0.37	-0.37	-0.38	0.01	-0.19	0.48
PER COR	0.43	0.18	-0.41	-0.27	0.29	-0.23	-0.28	0.43	-0.44	**0.82**	-0.19	0.02	**0.90**	1.00	-0.01	-0.37	-0.29	-0.38	-0.32	0.10	-0.15	0.44
STS AXI	0.46	**0.92**	-0.45	-0.26	**0.80**	0.20	-0.29	0.15	-0.31	-0.05	-0.11	0.01	0.41	-0.01	1.00	0.10	-0.26	-0.09	-0.19	0.04	-0.09	0.44
STS FUS	-0.11	0.02	0.23	-0.34	-0.03	-0.31	**0.90**	0.52	-0.45	-0.31	**0.84**	-0.37	-0.29	-0.37	0.10	1.00	**0.91**	-0.29	-0.33	-0.35	-0.34	-0.12
STS SPL	-0.14	-0.26	0.35	-0.22	-0.23	-0.33	**0.96**	0.44	-0.35	-0.28	**0.95**	-0.31	-0.37	-0.29	-0.26	**0.91**	1.00	-0.26	-0.27	-0.34	-0.20	-0.17
STP TYP	-0.20	-0.16	0.68	-0.29	-0.19	-0.34	-0.29	-0.50	**0.91**	-0.30	-0.27	-0.38	-0.37	-0.38	-0.09	-0.29	-0.26	1.00	-0.29	-0.37	-0.31	-0.21
TUB ARA	-0.16	-0.20	-0.38	**0.99**	-0.20	**0.89**	-0.25	-0.56	0.08	-0.31	-0.30	**0.79**	-0.38	-0.32	-0.19	-0.33	-0.27	-0.29	1.00	0.66	**0.87**	-0.14
TRI FAV	0.53	0.28	-0.27	0.66	0.41	**0.70**	-0.22	-0.56	-0.05	-0.31	-0.30	**0.95**	0.01	0.10	0.04	-0.35	-0.34	-0.37	0.66	1.00	0.67	0.59
TRI SCA	0.19	0.00	-0.46	**0.92**	0.07	**0.93**	-0.28	-0.54	0.00	-0.30	-0.08	**0.86**	-0.19	-0.15	-0.09	-0.34	-0.20	-0.31	**0.87**	0.67	1.00	0.15
TRI VAR	**0.99**	**0.75**	-0.16	-0.10	**0.89**	0.17	-0.13	-0.15	-0.22	-0.11	0.03	0.49	0.48	0.44	0.44	-0.12	-0.17	-0.21	-0.14	0.59	0.15	1.00

Plant community preference can be probably characterized as an aspect of species ecological niche. In fact, the isolation of preference groups from each other can be interpreted as the absence of niche overlap between species, using different preference. The reduction of niche overlap is usually considered to be a proof of competitive interactions in community [11]. Thus, at least for analyzed species, it is possible to ascertain a significant role of the competition in definition of their plant community differentiation. M. Schnittler [15] has shown, that only large, mainly lignophylic species with phaneroplasmodia, demonstrate a propensity to competition. Just this category of the species prevails in our analysis. Therefore, the offered model of plant community preferences can be effective only for such species of Myxomycetes.

The question about ecological and taxonomical affinity of species, united by one preference, is of interest too. To answer this question, two working hypotheses are possible: (1) one preference group is formed by species with similar biology and ecology, i.e. similar conditions unite together similar organisms; or (2) within the limits of one group the competition is stronger, therefore, to avoid competition, one group consists of species which have different features in some alternative (not phytosociological) field.

To find out which hypothesis is correct, we shall consider the substratum and taxonomic structure of groups (fig. 3). In the first group both species (*Lycogala epidendrum* and *Stemonitipsis typhina*) are obligate lignophiles, belonging to the different orders. In the second group lignophile (*L. terrestre*), corticophile (*Perichaena. corticalis*) and ligno-corticophile indifferent species (*Physarum album*) are situated. All of them are from the different orders. Third group include two lignophiles from the different orders (*Ceratiomyxa fruticulosa* and *Stemonitis splendens*), litter species with elements of corticophility (*Mucilago crustacea*) and substratum-indifferent species with elements of corticophility (*Stemonitis fusca*); last two species are also from different orders. The fourth group include two lignophiles, *Trichia varia* and *Arcyria obvelata* (of one order, but rather distant genera *Arcyria* and *Trichia*, sometimes allocated in different families), one corticophile (*A. cinerea*) and two substratum-indifferent species with elements of lignophily, *Stemonitis axifera* and *Arcyria affinis* (from different orders).

The fifth group demonstrates an originality in substratum differentiation: all of its species are lignophilic. It can be explained by both objective reasons (high richness of decayed wood in corresponding communities) and subjective factors (our research is based on results of field collections, which does not include the assemblage of small corticophilic species). However, species from fifth group develop on wood of different decomposition stages (unpublished observations): *Arcyria incarnata* and *Comatricha nigra* prefer II stage of decomposition (firm decorticated wood), *Trichia favoginea* and *T. scabra* prefer III stage (wood of an average degree of decomposition, without mosses), *Metatrichia vesparia* and *Tubulifera arachnoidea* prefer IV stage (fully decomposed wood, covered with mosses). Let us notice, that two of three considered pairs belong to different orders and the remainder, *Trichia favoginea* and *T. scabra*, differ on substrata spectrum (see fig. 3: *T. favoginea* was found on bark three times more often). Therefore, the second hypothesis looks to be more appropriate: the species, united by one preference group, develop mainly on different substrata. Living in the same plant community, Myxomycetes occupy various substrata, thus avoiding competition. This is a good illustration of competitive elimination principle [3].

In those rare cases when two or more species from one group occur on one substratum type, they appear to be from different orders. This supports the observations reported by Stephenson [17] that the competition between related species of Myxomycetes appears to be stronger than between unrelated species. Probably, the ecological niches of unrelated forms are delimitated by phenological and/or trophic parameters. The letter looks realistic: species from different orders can be expected to consume a different species of bacteria, thus avoiding competition.

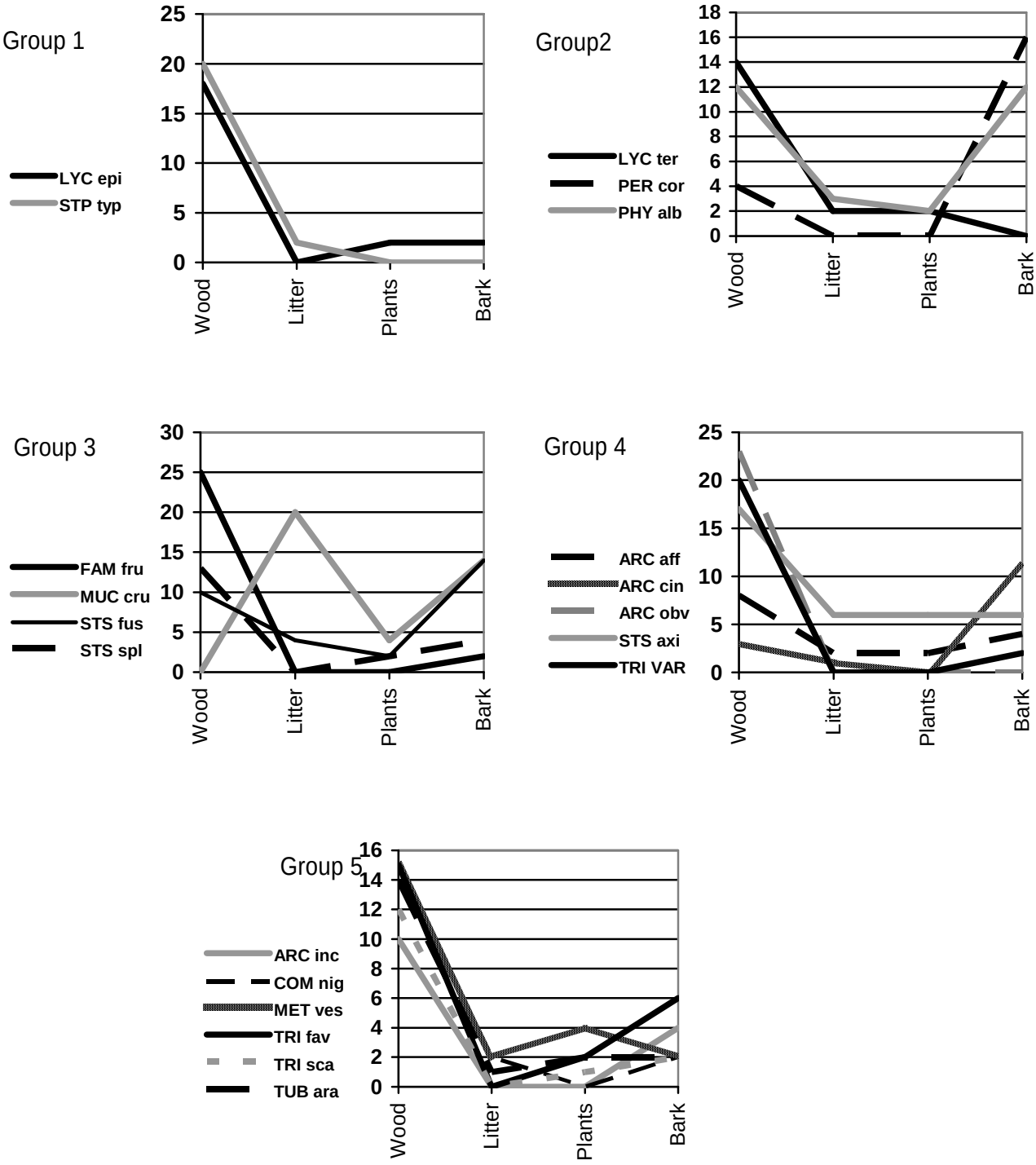

Fig. 3. Distribution of Myxomycetes species from preference groups on different substrata types. For species acronyms see Tab.1

Conclusions

1. Despite the outward indifference to a type of plant community, myxomycete species are united into strict groups with a certain system of community preferences.

2. The inclusion of a species to preference group is not the same as its belonging to certain community. It indicates the certainty of a place occupied by a species in the given community.

3. The number of preference patterns is limited, at least within the given geographic area, and appear to be a small proportion from a potentially possible number.

4. The strict borders between preference groups reflect the deep niche differentiation of Myxomycetes species.

5. The same preference pattern is used by species developing on different substrata or belonging to distant taxonomic groups. This indicates that Myxomycetes avoid competition by occurring on different substrata or using other (e.g. food) delimitations.

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